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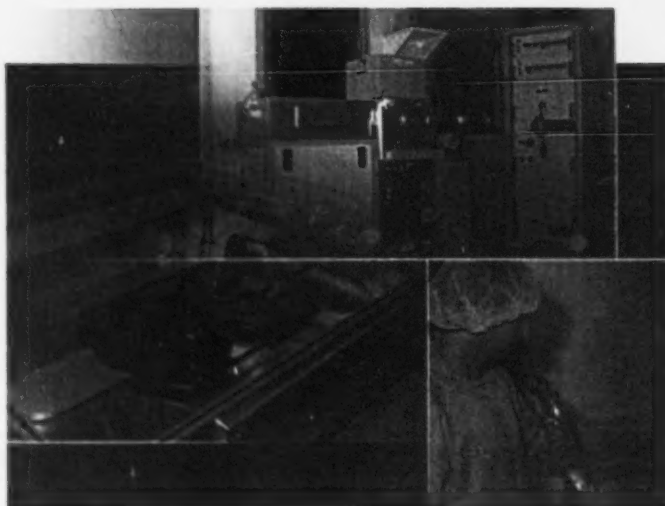
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Wafer processing in the Advanced Plasma Technology Lab at the Communications Research Centre (CRC).

Mining the Potential of Planar Lightwave Circuit Technology

Optical communication systems are all around us in today's "on-demand" society, from transatlantic fiber links supporting telephone service, to systems that bring TV and Internet services to homes, network workplace computers, or allow commercial or individual access to local or metro-area communication networks. In the not-too-distant future, optical technology will replace electrical wires connecting chips and circuit boards, which currently cause a communications "bottleneck," producing a new generation of high-speed super computers and networks. Optical technology will also yield applications that secure confidential data exchange, bringing significant benefits to many areas, including e-commerce, national security and the banking industry.

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These increasingly complex applications require, in addition to fiber links, devices that can route, switch, filter, attenuate, amplify and otherwise control the optical signals that carry valuable information. Like most things in a competitive business world, these devices must continually evolve to meet consumer demand for "better, faster, smaller and cheaper" or in other words, greater functionality and bandwidth, at reduced size and cost.

To address these applications, CRC's Photonics Component Technology (PCT) group is developing a suite of photonic devices based on silica-on-silicon planar lightwave circuit (PLC) technology. Planar layers of silica, the same material used in optical fibers, are deposited from a plasma under high vacuum, heated to high temperatures then patterned into device structures. The fabricated devices have dimensions and material characteristics similar to those of optical fibers, making them compatible with fiber infrastructure.

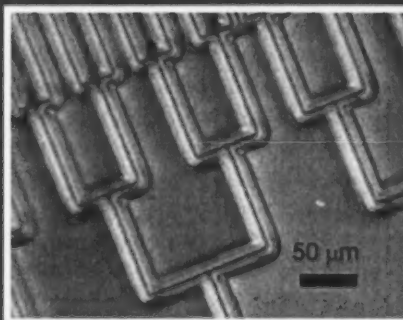
PCT researchers have access to state-of-the-art facilities to fabricate PLCs in-house and extensive expertise in design, process development and device characterization, advanced through their detailed study of the materials and processes required to build PLCs, conducted over the past few years. Researchers in the group are now exploiting this expertise for several different applications. The group also carries out custom device fabrication for industrial and university partners.

Closing the Gap between Optical and Electrical Signals

The PCT group has developed silica-based PLCs ranging from simple devices for guiding light, to more complex devices for manipulating the wavelength, phase and optical power in networks that employ separate wavelength channels on a

Silica Microchannels on a Chip Generate New Possibilities

A "Eureka moment" during the materials development phase of the PLC research led researchers to a novel suite of silica devices with microchannels embedded in the layers. During scanning electron microscope examination of a silica layer with standard optical waveguides etched into it, researchers noticed a set of closely spaced, highly uniform voids that had been formed during a high temperature treatment. The team developed processes to repeatedly form the microchannels to closely specified tolerances. These microstructures, which can be directly integrated with optical circuits, allow the optical properties of fluids to be efficiently exploited in optical devices. Recently, integrated sensors that can detect tiny changes in optical properties in a volume of liquid less than a billionth of a litre have been demonstrated. A new and exciting direction in this research is the incorporation, into fluids in microchannels, of nanoscale particles, which are emerging as interesting and unique optical materials. A U.S. patent on this process is pending. The PCT group is actively seeking partners interested in exploiting this technology for communications or other applications.



Silica microchannels on a chip, as seen through an optical microscope

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single fiber (wavelength division multiplexing or WDM). Current research is focussed on the development of next generation PLCs that, in addition to routing the light, can actually manipulate the bits and packets of information carried on the light beam. This type of all-optical processing is an important step forward in optical network technology as it potentially removes the need to convert optical signals back to the electrical domain to carry out signal processing functions.

Recently, collaboration with researchers at McGill University has resulted in the demonstration of interferometer devices that can increase the pulse repetition rate from 10GHz to 40GHz. By applying electrical currents to selected parts of the device, the phase of the propagating light can be controlled, and specific binary output codes generated. Researchers at McGill and CRC are developing this technology further, envisaging exciting applications, as all-optical signal processing becomes a reality.

The drive towards closer interaction between optical and electrical signals also motivates another research and development project in the PCT group. In order to fully exploit the speed and data capacity of optical interconnects, a technology is required that can interface optical and electrical signals on the same chip. However, there is currently a huge size differential between

photonics (micrometers) and silicon electronics ("computer chip technology") (nanometers). The PCT group is working on the development of photonic components based on multilayer structures in which thin metal strips are embedded in glass or polymer materials. These so-called "plasmonic structures" allow light to be guided in unique ways, they can reduce the dimensions of lightguiding components, and they have the potential for electrical connection.

Metal patterns with dimensions less than the wavelength of light create even more possibilities. The group has developed low-cost patterning techniques, enabling the in-house fabrication of nanoscale devices. Collaborators at Clemson University in South Carolina are actively participating in the supply of materials for this project. The work is at a fairly early stage, but this research topic has generated a lot of excitement in the world of photonics, and researchers at CRC hope it will allow them to move a few steps closer to developing an on-chip photonic/electronic interconnect.

For more information on CRC's research in planar lightwave circuit technology contact Claire Callender, Project Leader, Photonic Component Technologies, at 613-998-2726 or claire.callender@crc.ca.

CRC Among Pioneers of Healthcare Virtual Network

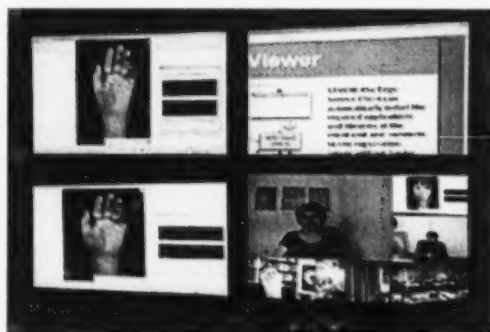
A severed hand appears on the screen, fingers curled slightly inward, the tips wrinkled like miniature prunes. A slight movement of the mouse causes the hand to rotate, giving first a view of the back, then of the two sides. With the external examination complete, the professor clears his throat and instructs the students to locate and expose the scaphoid on the hand on each of their computer screens. One student clicks her mouse and the skin on her "specimen" falls away to expose muscles, fatty tissue and bone. Another click peels away a second layer to reveal tendons, more muscles and bone. As the students work the professor monitors their progress, giving them feedback as they go.

At first glance this scene, although hypothetical, could take place in any anatomy class across Canada, but there is one important difference. In the scene above the professor is standing in Montreal, the students are sitting at computers in Sudbury and Thunder Bay, and the anatomical data on the severed hand is streaming to them all from Sunnyvale, California. Even the software used to render and manipulate the 3D image is located elsewhere; some of it in Sunnyvale, some of it at the National Research Council in Ottawa.

Given the current state of networks and technology this hypothetical class could now be in session, but only with a dedicated network of fixed connections between all the participating institutions, a solution that is both too expensive and too inflexible for most organizations to consider. A unique collaboration, however, between several universities, government laboratories and private companies, is on the verge of changing all that.

On June 26, 2008 CANARIE Inc. announced funding for The Health Services Virtual Organization (HSVO) under its Network-Enabled Platforms program. Spearheaded by the Northern

Ontario School of Medicine (NOSM) and McGill University, the project brings together NOSM and McGill with Stanford and Lakehead Universities; the Communications Research Centre and National Research Council; iDeal Consulting and Innovation in Learning, Inc. CANARIE Inc. is Canada's advanced network organization and is supported by membership fees, with major funding of its programs and activities provided by the federal government through Industry Canada.



When the HSVO team met in CRC's BADLAB in October, some partners joined by video conference (lower right). Images of a specimen hand appear on the BADLAB screens to the left.

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The goal of HSVO is to create a virtual network designed to link the most advanced medical resources – data, devices and healthcare experts – to students and healthcare professionals at widely dispersed locations. When completed, users will have access to a state-of-the-art virtual network for use in training, patient treatment and research collaboration. Because the network is “virtual” rather than being based on fixed connections, users can form and create the network connections they require to suit their immediate task, whether that be an anatomy class at dispersed locations or interaction with a “virtual patient” located at a server in a distant city.

“Our role at CRC,” says Michel Savoie, Research Manager for CRC’s Broadband Applications and Optical Networks group, “is to look after network infrastructure. We need to verify that the physical connections are in place to all the participating sites, then we have to virtualize the network elements. That’s what creates this virtual private network.” And the challenges, he explains, are considerable.

To begin with, the resources, whether databases, experts, or interactive surgical mannequins, may be

located thousands of kilometers apart. To provide the speed and interactivity the users demand thus requires large amounts of dedicated bandwidth simultaneously linking multiple servers to the users’ computers. To complicate things further, the users are experts in medicine, not computers. They require access to complex services and tools – HD videoconferencing, Canadian Medical Association guidelines, virtual patient simulation – but this access must be seamless and simple, the result of a few clicks of a mouse.

The HSVO virtual network, says Savoie, will rely on two critical software technologies. The user interacts with a program called SAVOIR – developed by the National Research Council – through a “dashboard” of icons on their desktop. The icons represent the services and devices available through the virtual network. Once icons are clicked to open a session, SAVOIR orchestrates and manages the session, ensuring that all the dispersed services arrive and function on the users’ computers, and all the session-users can interact both with these “Edge Services” and with each other. This involves SAVOIR contacting multiple servers located across North America, but the important thing,



HSVO partners at a planning retreat held at the NOSM campus in Sudbury in August. Back row, left to right: Michel Savoie, Bobby Ho, René Richard, Martin Brooks, Bruce Spencer, David Topps. Front row, left to right: Sandy Liu, Parvati Dev, Rachel Ellaway, Kevin Smith, Jeremy Cooperstock, John Spence.

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says Savoie, is that beyond clicking on icons and choosing a common channel for interactive sessions, this flurry of activity is hidden from the user.

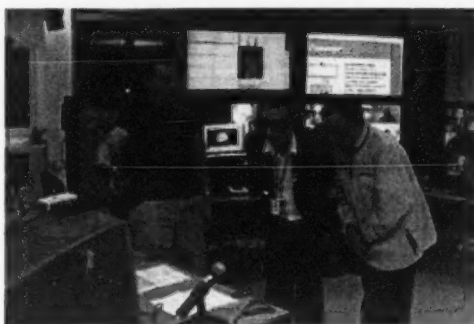
"If you're a doctor," says Savoie, "you don't want to know all the particulars of how the virtual network has been set up and what needs to be done to make it work. You also don't need to know where all the software and the databases are located. All you need are the icons that represent the tasks you want to do."

To achieve the speed and interactivity needed by HSVO users, however, requires more than just SAVOIR's excellent management. It also requires high bandwidth dedicated for the duration of the session. To accomplish this, the virtual network relies on another program, ARGIA, developed by CRC. ARGIA is designed to create and manage lightpaths – dedicated links – even across independently managed networks and domains, a critical necessity for any widely dispersed virtual network. At the behest of SAVOIR, ARGIA opens the necessary lightpaths on a schedule, and in a manner, determined by its instructions from SAVOIR. An analogy, says Savoie, would be getting dedicated access to a superhighway.

"ARGIA not only gives you your own on-ramp," he says, "it gives you your own lane. Since there's no one in front of you, you can go as fast as you want. More importantly, you can set this up whenever you need it – whenever you have somewhere to go – and when you're finished the resource is then freed up for others to use."

Since SAVOIR sessions and configurations can be saved, pre-scheduled, and organized to stop and start at specific times, the technology has enormous potential for distance learning and collaborative research. By the project's end in June 2010, HSVO will link McGill's Medical Simulation Centre and Shared Reality Lab (Montreal), the Northern Ontario School of Medicine (Thunder

Bay and Sudbury) and a suite of edge services and devices. These will include access to 3D anatomical visualization through the Bassett Collection and the Visible Human database; the ability to participate from a remote location in cadaver dissections in Montreal; and virtual patient simulations supported by simultaneous access to treatment guidelines and bibliographic information services.



Bobby Ho (left), Research Engineer with CRC's Broadband Applications and Optical Networks group, demonstrates three dimensional potential of HSVO applications to partners wearing 3D glasses.

Beyond that, says Savoie, the future goal is to deploy ARGIA and SAVOIR on a computing cloud, possibly even a commercial computing cloud such as Amazon's Elastic Computing Cloud (EC2), allowing not only for transparent scaling of HSVO, but for a more efficient use of computing resources with a resultant decrease in carbon footprint.

"Our project," says Savoie, "won't address all the issues, but it will set the stage, take care of the initial implementation, and ensure that the design can grow to accommodate what is needed when the full HSVO virtual network is developed."

For more information on CRC's role in HSVO contact Michel Savoie, Research Manager, Broadband Applications and Optical Networks, at 613-998-2489 or michel.savoie@crc.ca.

Spectrum Explorer Helping Reduce Security Risks

In February 2010, Vancouver will play host to the Olympic and Paralympic Winter Games, the globe's premier international sporting event. With 80 countries participating in over 200 events at 15 different venues, 1.6 million tickets now on sale, and an expected 3 billion television viewers worldwide, visitors will be numerous, and some, high profile. Supporting Games-time operations and public safety and security agencies in this complex, distributed and fast-paced environment will require not only planning and manpower, but the latest technology in radio surveillance, including CRC's Spectrum Explorer®.

Industry Canada has the mandate to manage the efficient use of Canada's radio spectrum and provide support for public safety related activities. It also has the lead role for emergency telecommunications in Canada.

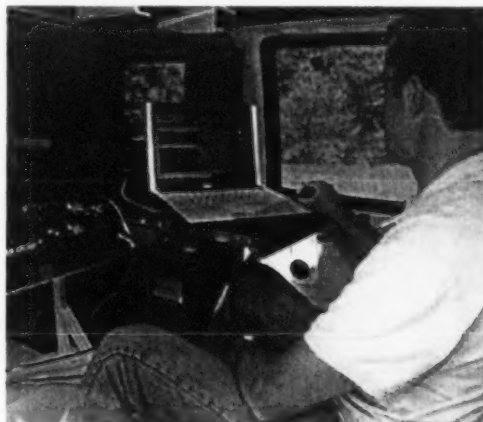
"Industry Canada will be present at the Vancouver 2010 Winter Games to provide spectrum management and interference mitigation for this event," explains John Lodge, Research Program Manager in charge of spectrum monitoring R&D at CRC. "Industry Canada's Vancouver regional office and CRC will have both fixed site and mobile monitoring capabilities at this event. The overall radio traffic is expected to be extremely heavy, resulting in many issues that will require quick resolution."

In preparation for these events, CRC participated in a unique demonstration of technology organized by the Major Events Coordinated Security Solutions project (MECSS) on October 24. MECSS is a special project under the Public Security Technical Program, which is led by Defence Research and Development Canada's Centre for Security Science. It aims to assist authorities in reducing

the security risk associated with major events, such as the Vancouver 2010 Winter Games and the G8 Summit, through the coordinated application of science and technology (S&T).

"The federal S&T community has developed innovative systems for information management and decision support, systems that could play an important role in maintaining security and public safety at events like the 2010 Winter Games," explains CRC's Luc Boucher, Program Manager, Wireless Applications and Systems Research, and a member of the MECSS working group. "But for these systems to reach their full potential, federal, provincial and municipal organizations in charge of public safety and security have to know they exist and have to be able to access them."

The October 24 showcase, which brought together federal technology developers from various departments and agencies, included a full-day demonstration, with a VIP session for some senior public servants in the afternoon. Exhibitors included Health Canada, Environment Canada, Ottawa Police Services, the Royal Canadian Mounted Police and CRC's Charles Benoit, demonstrating the Spectrum Explorer.



Charles Benoit, Research Engineer, Communications Signal Processing group, demonstrating Spectrum Explorer.

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Spectrum Explorer is a sophisticated radio surveillance system that can be used to detect and analyze communication signals, as well as locate the source of the signals. What makes the system so attractive for security and policing personnel is its small size and flexibility. Unlike older systems that gobbled power, were noisy, and had to be mounted on a rack due to their weight and size, Spectrum Explorer is compact, portable and flexible – the size of shoebox attached to a laptop – and can be operated from a small van or car.

The heart of the Spectrum Explorer, Charles Benoit explains, is the wideband scanner. By directing a tuner (like that in a radio) to sweep a broad range of frequencies, and directing the information via a digitizer to the laptop, the information is then displayed as an energy spectrum, as channels, and/or as detections. Since each device – for example a cell phone – uses a specific frequency when transmitting, it boosts the energy at that frequency. This shows up as a sharp spike at that frequency on the wideband scanner display.

Once a spike is detected, the user can then get a detailed analysis of that signal using other facets of the program. For example, the direction finder allows the user to pinpoint the location of the emitter. Using the spectrum analyzer the user can zero in on a narrow band of the spectrum and identify the type of signal being transmitted (AM, FM, SSB, GMSK, etc.). For more information on Spectrum Explorer, please see *Eye on Technology* Issue No.4 – Summer 2006.

One of the big concerns at international events like the Olympic and Paralympic Games is radio interference. Each country regulates its own radio spectrum differently, and not all countries allot the same bands to the same uses. With

so many international visitors expected at the Olympics, it is entirely possible that a visitor could arrive with a wireless communication device that transmits on the same frequency used by Vancouver's police or ambulance service, thus interfering with emergency response measures. Spectrum Explorer will be used to scan the radio spectrum throughout the event, identify problematic signals and locate the sources so that the problem can be resolved.

While other systems exist for monitoring and analyzing the RF spectrum, Benoit stresses that Spectrum Explorer has several characteristics that make it unique. Because it can be run using over 20 readily-available hardware configurations, clients aren't tied into buying high-cost hardware. With a range of equipment to choose from they can base their decision on their budget and needs. Spectrum Explorer is also "open-software" making it easy to add applications as the need arises.

"We've done a lot of work integrating a low-cost platform into a small package to get into the market of mobile spectrum analysis and monitoring," says Benoit. "Some departments and countries don't have big budgets, so we needed a low-cost solution, and that's what we can offer them now."

For more information on CRC's participation in MECSS contact Luc Boucher at luc.boucher@crc.ca. For information on the Spectrum Explorer contact John Lodge at john.lodge@crc.ca or visit the *Spectrum Explorer* web site.

Awards and Recognition

And the Emmy Goes to... CRC's Advanced Television Evaluation Laboratory

CRC's Advanced Television Evaluation Laboratory (ATEL) will share in an Emmy Award to be presented at the January 2009 Technology & Engineering Emmy Awards ceremony in Las Vegas.

ATEL is among four organizations being recognized for their contributions to standardizing the digital television system, known as Advanced Television Systems Committee (ATSC), which will soon replace the current analog television system, known as National Television System Committee (NTSC). The switch will take place in the United States by February 17, 2009, and in Canada by August 31, 2011.

ATEL will share the Emmy with the Advisory Committee on Advanced Television Service, the Advanced Television System Committee and the Advanced Television Test Center.

Additional information can be found at:
http://www.crc.ca/en/html/crc/home/mediazone/whatsnew/nov3-7_08_2.



John Lodge named IEEE Fellow

The Institute of Electrical and Electronics Engineers (IEEE) has named CRC's John Lodge IEEE Fellow with the citation: "For contributions to the application of signal processing and communications theory."

John was among a select group of engineers elevated to Fellow by the IEEE Board of Directors, following the recommendation of the Fellow Committee. The designation takes effect January 1, 2009.



John is Research Program Manager in CRC's Communications Signal Processing group.

Advanced Radio Systems Group Recognized for Papers

Steve Bernier and François Lévesque of CRC's Advanced Radio Systems group were recently recognized by the SDR Forum for their paper "Interconnecting JTRS SCA Applications Development." The paper, presented at the SDR 2007 technical conference, received a Best Paper Award at the SDR 2008 technical conference, held in Washington, D.C., in October.

Approaching each annual conference, SDR Forum's best paper selection committee measures the impact of papers presented the previous year, in several categories. This is actually the second SDR Forum Best Paper Award for members of the Advanced Radio Systems group. They were also recognized in 2004.

Steve Bernier is Project Leader, Software Defined Radio, and François Lévesque is Computer Researcher, Advanced Radio Systems group.

Satellite Systems Group Researcher Recognized for Presentation

Richard Paiement received a Best Presentation Award from the Institute of Navigation for his paper, "Dilution of Precision Factor in Medium Earth Orbit Search and Rescue Systems." Richard's paper was presented at the 21st International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2008), held in Savannah, Georgia in September. It reported on results from an R&D project, partially funded by the New Initiatives Fund program of Canada's National Search and Rescue Secretariat, to investigate the impact of MEOSAR constellation on position estimation accuracy over Canada for different geolocation techniques.

Richard is Project Leader, Advanced Systems and Technologies, in CRC's Satellite Systems Research division.

Licensing Corner

SARSAT Wins Technology Transfer Award

On June 2, at a gala luncheon held in Ottawa, SARSAT (Search and Rescue Satellite Aided Tracking) team members from CRC, Canadian Space Agency, EMS Satcom, National Search and Rescue Secretariat, and National Defence

were honoured with a Federal Partners in Technology Transfer Award (FPTT) by the Government of Canada. The award recognizes excellence in the development, transfer and commercialization of significant technologies.

SARSAT was initially developed by the CRC in the mid-1970s, but the network now encompasses over 38 countries and has resulted in sales revenues to Canadian companies of \$100M in the past 25 years. SARSAT is credited with the rescue of over 22,000 people since 1982. Of special note, said the award's judges, was the work of CRC's Jim King who, despite the hostility and mistrust of the Cold War era, was able to broker a collaborative agreement with the Russian Space Agency in 1979.

Innovation Centre Welcomes New Clients

The Communications Research Centre has welcomed two new clients to its Innovation Centre. On October 15, CRC signed an agreement with Ottawa-based Forsetic Semiconductor, a well-established designer of RF (radio frequency) chips for major clients across North America. Forsetic will be working with CRC's Integrated Electronics Research Group to develop their own proprietary RF chip.

Polynat, an Ottawa start-up, will be specializing in standards-based objective testing of telecom products and technologies. Through CRC's Broadband Applications and Demonstration Laboratory (BADLAB), Polynat will acquire access to CRC's unique live research network for use in testing and development, including the possibility of extending testing to include the CANARIE network, optical regional networks (ORANs) and connected, remote institutions. The agreement was signed on November 1.

For information on CRC's Innovation Centre contact Kevin Shackell, Manager, Technology Commercialization, at 613-998-0138 or kevin.shackell@crc.ca.

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Mexico Chooses CRC-COVLAB

In the biggest-ever block acquisition of CRC-COVLAB technology, the Government of Mexico has purchased 10 licenses for the software in a deal that includes training of Mexican specialists in the use of the technology. CRC-COVLAB gives the Mexican government the most powerful tool available to model and predict broadcast coverage and interference

in the face of new and impending broadcast technologies, including digital and hybrid systems. With the help of CRC-COVLAB, the Government of Mexico will be able to manage and plan spectrum use to ensure effective and efficient broadcast services now and in the future.

For more information contact René Voyer, Research Manager, Broadcast Technologies, at 613-998-4407 or rene.voyer@crc.ca.



CRC's mission is to be the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes. CRC also aims to help identify and close the innovation gaps in Canada's communications sector by:

- ▶ *engaging in industry partnerships;*
- ▶ *building technical intelligence;*
- ▶ *supporting small and medium-sized high technology enterprises.*